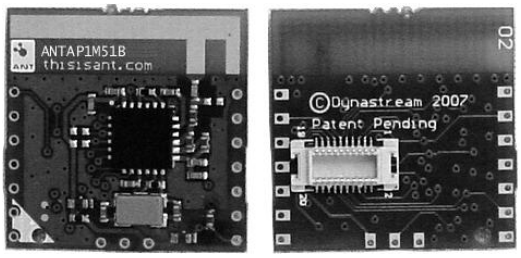
DYNASTREAM®
INNOVATIONS

ANTAP1MxIB RF Transceiver Module

FEATURES

- 2.4GHz worldwide ISM band
- 20mm x 20mm drop-in module
- Ultra low power operation
- Simple sync/async serial interface
- Integrated F antenna
- Broadcast, acknowledged, or burst data transmissions
- ANT channel combined message rate up to 200Hz (8byte data payload)
- Minimum message rate per ANT channel 0.5Hz
- Burst transfer rate up to 20Kbps (true data throughput)
- Up to 4 ANT channels
- Up to 3 public, managed and/or private network keys
- 1 Mbps RF data rate
- 125 selectable RF channels
- 1.9V to 3.6V supply voltage range
- -40°C to +85°C operating temperature
- FCC test ready
- RoHS compliant

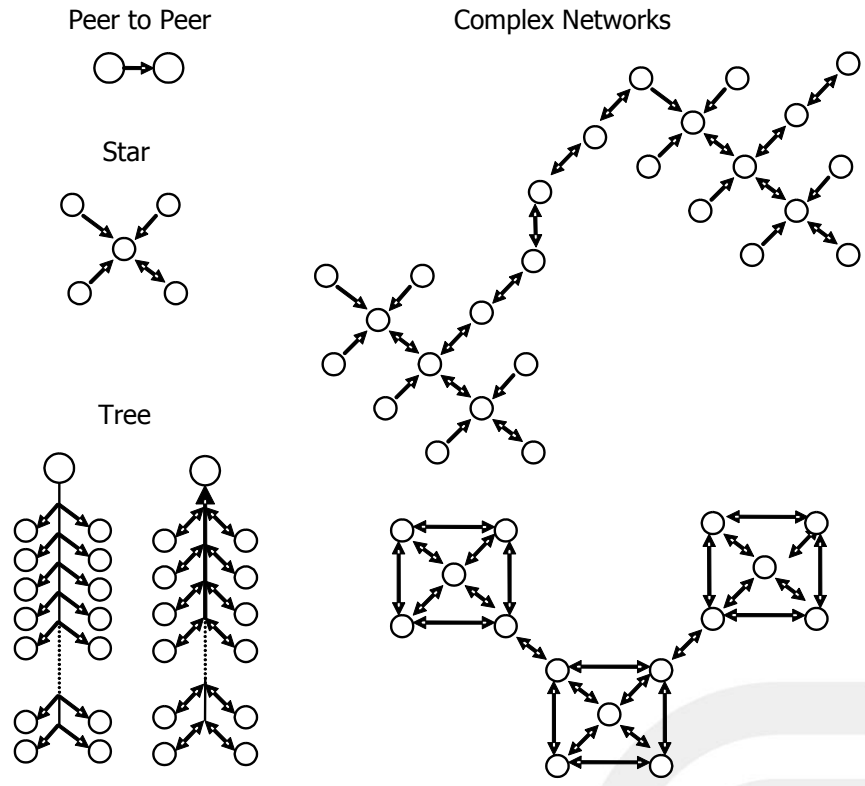


FAMILY MEMBERS

ANTAP1M4IB

ANTAP1M5IB

ANT NETWORK CONFIGURATIONS



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Notices and Restricted Use Information

Restricted use of ANT RF Transceiver Modules.

The ANT RF Transceiver Module has not been certified for use by the FCC in accord with Part 15, or to other known standards of operation governing radio emissions. Distribution and sale of this RF Transceiver Module is intended solely as a component of an end-product(s) that is subject to FCC regulation, or other authorities governing radio emission. This RF Transceiver Module may not be resold by users for any purpose. Operation of the RF Transceiver Module in the development of future devices is deemed within the discretion of the user and the user shall have all responsibility for any compliance with any FCC regulation or other authority governing radio emission of such development or use. All products developed by the user must be approved by the FCC or other authority governing radio emission prior to marketing or sale of such products to consumers and user bears all responsibility for obtaining the authority's prior approval, or approval as needed from any other authority governing radio emission. If user has obtained the RF Transceiver Modules for any purpose not identified above, user should return the RF Transceiver Modules to Dynastream Innovations Inc. immediately. Dynastream makes no representation with respect to the adequacy of the RF Transceiver Modules in developing low-power wireless data communications applications or systems. The RF Transceiver Modules operate on shared radio channels. Any Products using ANT RF technology must be designed so that a loss of communications due to radio interference or otherwise will not endanger either people or property, and will not cause the loss of valuable data. Dynastream assumes no liability for the performance of products which are designed or created using the RF Transceiver Modules.

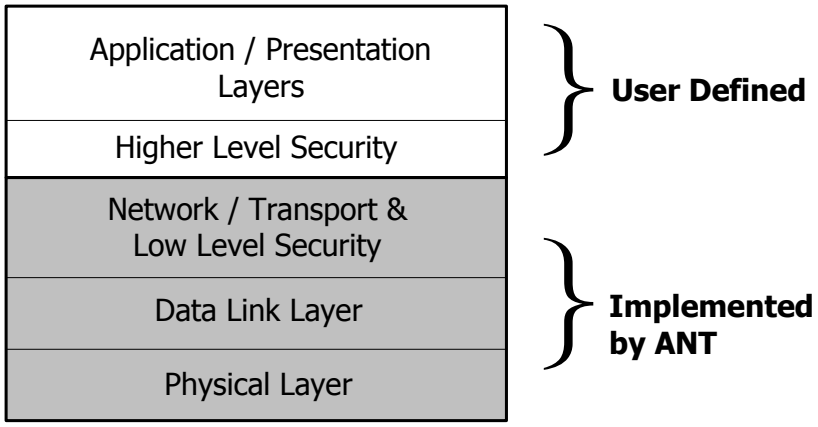
The Dynastream Innovations Inc. ANT Products described by the information in this following document are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Dynastream product could create a situation where personal injury or death may occur. If you use the Products for such unintended and unauthorized applications, you do so at your own risk and you shall indemnify and hold Dynastream and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Dynastream was negligent regarding the design or manufacture of the Product.

The information contained in this document is subject to change without notice and should not be construed as a commitment by Dynastream Innovations Inc. unless such commitment is expressly given in a covering document.

ANT™ Overview

ANT™ is a practical wireless sensor network protocol running on 2.4 GHz ISM band. Designed for ultra low power, ease of use, efficiency and scalability, ANT easily handles peer-to-peer, star, tree and practical mesh topologies. ANT provides reliable data communications, flexible and adaptive network operation and cross-talk immunity. ANT's protocol stack is extremely compact, requiring minimal microcontroller resources and considerably reducing system costs.

ANT provides carefree handling of the Physical, Network, and Transport OSI layers. In addition, it incorporates key low-level security features that form the foundation for user-defined, sophisticated, network-security implementations. ANT ensures adequate user control while considerably lightening computational burden in providing a simple yet effective wireless networking solution.



ANT supports public, managed and private network architectures with 2^{32} uniquely addressable devices possible, ensuring that each device can be uniquely identified from each other in the same network.

ANT is proven with an installed base of over two million nodes in ultra low power sensor network applications in sport, fitness, home and industrial automation. The ANT solutions are available in chips, chipsets and modules to suit a wide variety of application needs.

A complete description of the ANT message protocol is found in the ANT Message Protocol and Usage document. The serial interface details are provided in the Interfacing with ANT General Purpose Chipsets and Modules document.

1 ANT AP1 Module

The ANTAP1MxIB module is a single chip drop-in module based on the nRF24AP1 chip from Nordic Semiconductor. An F antenna is integrated on the small-sized 20mm by 20mm board. Able to support 4 ANT channels, the module is ideal to build control or hub nodes of a wireless sensor network.

Module	Description
ANTAP1M4IB	Surface mountable, 4 ANT channels, 20x20mm, industrial temperature range
ANTAP1M5IB	With Molex connector, 4 ANT channels, 20x20mm, industrial temperature range

The module has been pre-tested by a FCC registered lab to comply with the requirements for FCC CFR47 and other applicable standards for Intentional Radiators.

1.1 Pin Assignment

The module may be connected to the user's host controller using the 17 pin-out assignment (surface mount) style or the 20-pin Molex header connection style provided below:

Surface Mount Pin	Molex Header Pin	Pin Name	Async Mode	Sync Mode	Description
1	6	NC	NC	NC	No connection
2	10	NC	NC	NC	No connection
3	1	V_{CC}	V_{CC}	V_{CC}	Power supply source
4	19	GND	GND	GND	Power supply ground
5	8	NC	NC	NC	No connection
6	17	$\overline{\text{SUSPEND}}$ / $\overline{\text{SRDY}}$	$\overline{\text{SUSPEND}}$	$\overline{\text{SRDY}}$	Async -> Suspend control Sync -> Serial port ready
7	15	SLEEP/ $\overline{\text{MRDY}}$	SLEEP	$\overline{\text{MRDY}}$	Async -> Sleep mode enable Sync -> Message ready indication
8	13	NC	NC	NC	No connection
9	11	PORTSEL	PORTSEL (Tie to GND)	PORTSEL (Tie to V_{CC})	Asynchronous or synchronous port select
10	7	BR2/SCLK	BR2	SCLK	Async -> Baud rate selection Sync -> Clock output signal
11	4	TXD0/SOUT	TXD0	SOUT	Async -> transmit data signal Sync -> Data output
12	3	RXD0/SIN	RXD0	SIN	Async -> Receive data signal Sync -> Data input
13	5	BR1/SFLOW	BR1	SFLOW	Async -> Baud rate selection Sync -> Bit or byte flow control select
14	9	NC	NC	NC	No connection
15	14	NC	NC	NC	No connection
16	12	EXT32K	EXT32K	EXT32K	External 32kHz clock signal. Please see electrical specifications
17	2	RTS/SEN	RTS	SEN	Async -> Request to send Sync -> Serial enable signal
	16,18,20	NC	NC	NC	No connection

1.2 32kHz Clock Signal (EXT32K)

A 32.768kHz clock signal may optionally be provided to the module. If this signal is not used, it must be connected to ground. Please see the electrical specification section for external clock specifications. Use of an external clock is recommended for power sensitive applications. The module automatically detects the presence of an external clock source upon power up. In order to avoid timing issues between when the external clock source becomes present and when the module samples for this signal, it is recommended that a SystemReset command (please refer to ANT Message Protocol and Usage) is issued to the module upon initial connection. This will ensure that the external clock is properly detected and used. Once the EXT32K signal has been provided on power up it must remain present as long as the module remains powered up.

1.3 Asynchronous Baud Rate

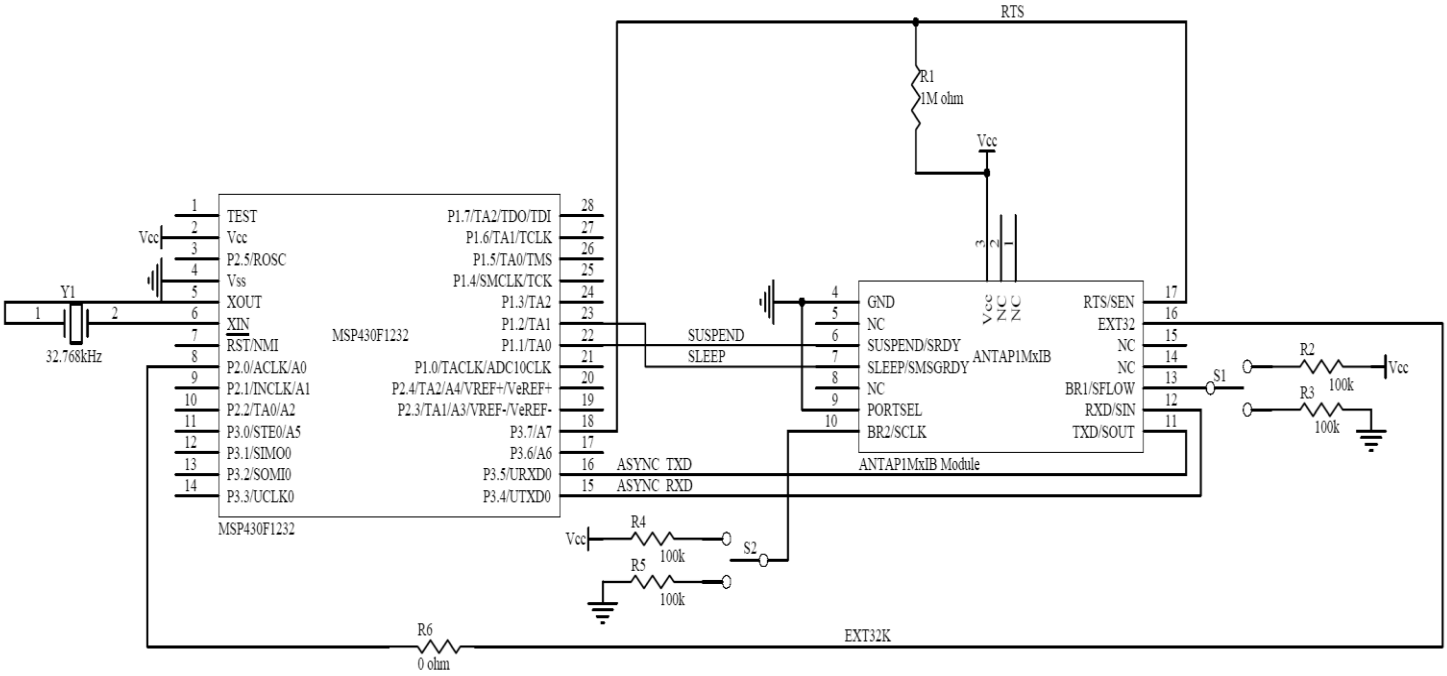
The baud rate of the asynchronous communication is controlled by the speed select signals BR1 and BR2. The table below shows the relationship between the states of the speed select signals and the corresponding baud rates.

BR2	BR1	Baud Rate
0	0	4800
1	0	19200
0	1	38400
1	1	50000

2 Sample Designs

The following sample designs show the proper electrical connectivity of an ANTAP1MxIB module to an application microcontroller.

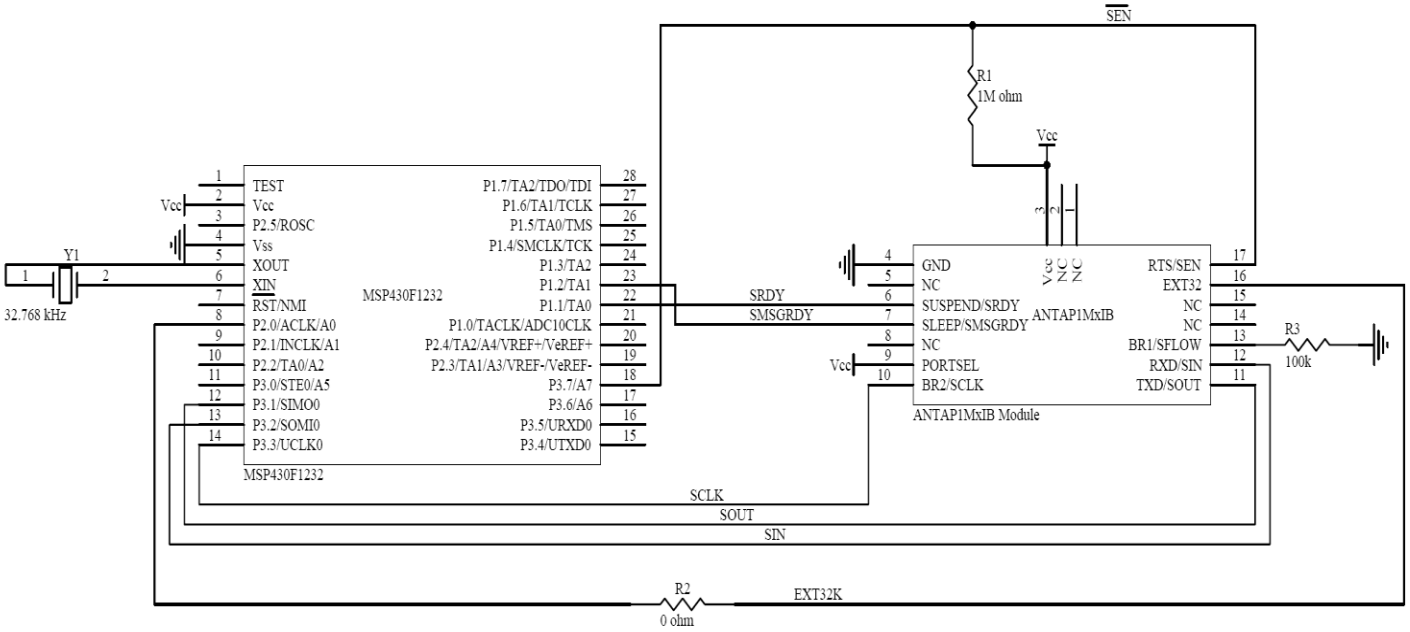
2.1 Async Mode



Notes:

- Module RXD and TXD connected directly to hardware USART of microcontroller.
- Switches on baud rate selection pins (BR1 and BR2) are for ease of use only. They can be connected directly to the logic level of interest.
- The SUSPEND line can be used for the purpose of RESET. This is achieved by holding SLEEP low, bringing SUSPEND low and then raising SUSPEND high again.
- R6 allows use of the optional EXT32K signal.

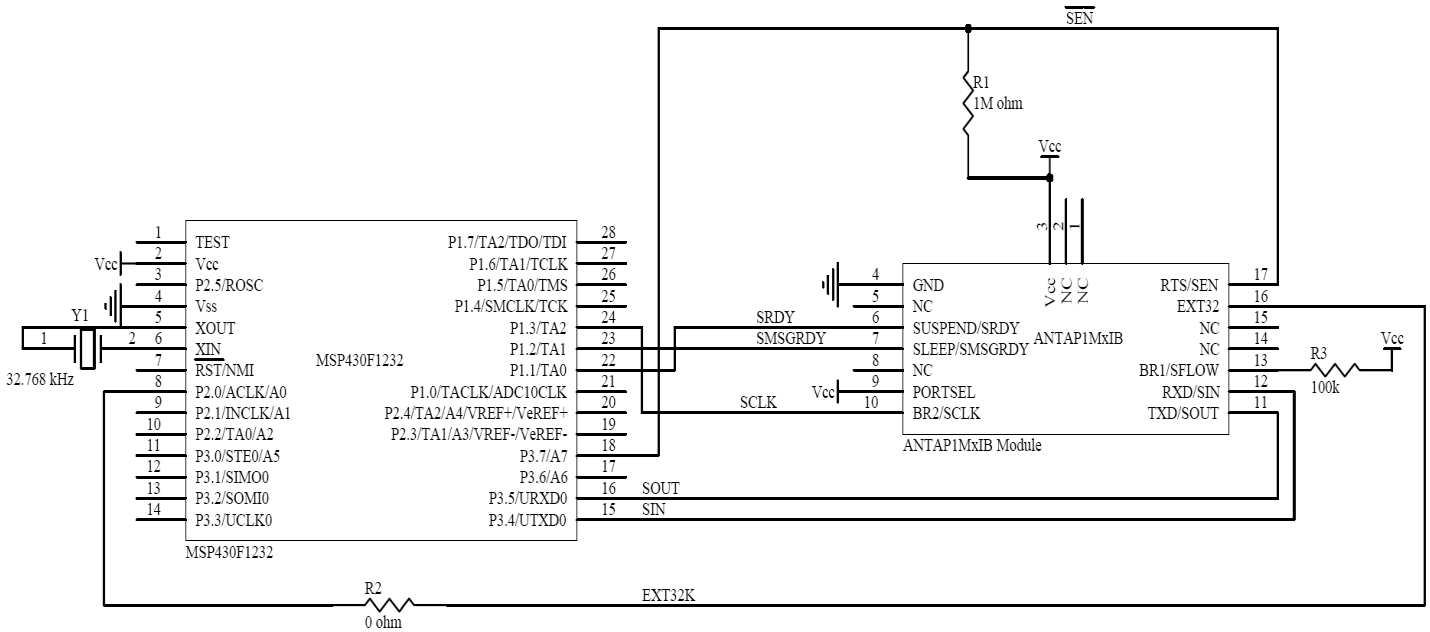
2.2 Byte Sync Mode



Notes:

- Module SOUT, SIN, and SCLK connected directly to hardware USART of microcontroller.
- $\overline{\text{SEN}}$ needs to be on an interrupt capable I/O pin on the microcontroller.
- The Synchronous RESET sequence must be applied to ANT for synchronization of the host mcu with the ANT module. Please refer to "Interfacing with ANT General Purpose Chipsets and Modules"
- R2 allows use of the optional EXT32K signal.

2.3 Bit Sync Mode



Notes:

- All interface signals are connected directly to I/O pins on the microcontroller.
- SCLK and $\overline{SEN}$ need to be on an interrupt capable I/O pin on the microcontroller.
- The Synchronous RESET sequence must be applied to ANT for synchronization of the host mcu with the ANT module. Please refer to "Interfacing with ANT General Purpose Chipsets and Modules"
- R2 allows use of the optional EXT32K signal.

3 Electrical Specifications

Absolute Maximum Ratings	
Voltage applied at V_{CC} to V_{SS}	-0.3V to +3.6V
Input Voltage at any pin	-0.3V to V_{CC} + 0.3V
Operating Temperature	-40ºC to +85ºC

Note: Stress exceeding one or more of the above maximum ratings may cause permanent damage.

Conditions: V_{CC} = +3.3V, V_{SS} = 0V, T_A = - 40ºC to +85ºC

Symbol	Parameter (condition)	Notes	Min	Typ.	Max	Units
	Operating conditions					
V_{CC}	Supply voltage		1.9	3.0	3.6	V
T_A	Operating Temperature		-40	25	+85	ºC
	Digital input pin					
V_{IH}	HIGH level input voltage		0.7V_{CC}		V_{CC}	V
V_{IL}	LOW level input voltage		V_{SS}		0.3 V_{CC}	V
	Digital output pin					
V_{OH}	HIGH level output voltage (I_{OH}=-0.5mA)		V_{CC} - 0.3		V_{CC}	V
V_{OL}	LOW level output voltage (I_{OL}=0.5mA)		V_{SS}		0.3	V
	Crystals and clocks					
f_{32K}	External clock source			32.768		kHz
$f_{32K\text{-}ERROR}$	Maximum error for external clock source				50	PPM
	Synchronous Serial Timing					
SCLK freq.	Synchronous clock frequency (byte mode)			150-175		kHz
$t_{ReadValid}$	Data is valid on read before low to high transition on the clock (byte mode)		0.5			us
$t_{WriteValid}$	Data must be valid on write within this time after a high to low transition on the clock (byte mode)				2	us
t_{SRDY_MinLow}	Minimum $\overline{\text{SRDY}}$ low time		2.5			us
t_{Reset}	Synchronous Reset. $\overline{\text{SRDY}}$ falling edge to $\overline{\text{SMSGRDY}}$ falling edge		250			us
	General RF conditions					
f_{OP}	Operating frequency	1)	2400		2524	MHz
$F_{CHANNEL}$	Channel spacing			1		MHz
Δf	Frequency deviation			±156		kHz
	Current Consumption					
I_{Idle_Ext32K}	No active channels – No communications (EXT32K and SLEEP_EN)			2		µA
$I_{Suspend}$	Asynchronous Suspend Mode			70		µA
$I_{Base\ EXT32K}$	Base Active current with EXT32K			35		µA
I_{Base}	Base Active current without EXT32K	2)		75		µA
$I_{Msg\_Rx\_ByteSync}$	Average current / Rx message in byte sync mode			19		µA
$I_{Msg\_Rx\_BitSync}$	Average current / Rx message in bit sync mode			29		µA
$I_{Msg\_Rx\_50000}$	Average current / Rx message in async mode at 50000 baud			21		µA

Symbol	Parameter (condition)	Notes	Min	Typ.	Max	Units
$I_{Msg\_Rx\_38400}$	Average current / Rx message in async mode at 38400 baud			24		µA
$I_{Msg\_Rx\_19200}$	Average current / Rx message in async mode at 19200 baud			32		µA
$I_{Msg\_Rx\_4800}$	Average RF current / Rx message in async mode at 4800 baud			85		µA
$I_{Msg\_Tx\_ByteSync}$	Average current / Tx-only message in byte sync mode			11		µA
$I_{Msg\ Tx\ BitSync}$	Average current / Tx-only message in bit sync mode			26		µA
$I_{Msg\_Tx\_50000}$	Average current / Tx-only message in async mode at 50000 baud	4)		19		µA
$I_{Msg\_Tx\_38400}$	Average current / Tx-only message in async mode at 38400 baud	4)		21		µA
$I_{Msg\_Tx\_19200}$	Average current / Tx-only message in async mode at 19200 baud	4)		37		µA
$I_{Msg\_Tx\_4800}$	Average current / Tx-only message in async mode at 4800 baud	4)		119		µA
$I_{Msg\_TR\_ByteSync}$	Average current / Tx message in byte sync mode			26		µA
$I_{Msg\_TR\_BitSync}$	Average current / Tx message in bit sync mode			38		µA
$I_{Msg\_TR\_50000}$	Average current / Tx message in async mode at 50000 baud	4)		33		µA
$I_{Msg\_TR\_38400}$	Average current / Tx message in async mode at 38400 baud	4)		35		µA
$I_{Msg\_TR\_19200}$	Average current / Tx message in async mode at 19200 baud	4)		49		µA
$I_{Msg\_TR\_4800}$	Average current / Tx message in async mode at 4800 baud	4)		131		µA
$I_{Msg\ Ack\ Rx\ ByteSync}$	Average current / Acknowledged Rx message in byte sync mode			28		µA
$I_{Msg\_Ack\_Rx\ BitSync}$	Average current / Acknowledged Rx message in bit sync mode			51		µA
$I_{Msg\_Ack\_Rx\ 50000}$	Average current / Acknowledged Rx message in async mode at 50000 baud			38		µA
$I_{Msg\ Ack\ Rx\ 38400}$	Average current / Acknowledged Rx message in async mode at 38400 baud			42		µA
$I_{Msg\_Ack\_Rx\ 19200}$	Average current / Acknowledged Rx message in async mode at 19200 baud			48		µA
$I_{Msg\_Ack\_Rx\_4800}$	Average current / Acknowledged Rx message in async mode at 4800 baud			102		µA
$I_{Msg\ Ack\ Tx\ ByteSync}$	Average current / Acknowledged Tx message in byte sync mode			37		µA
$I_{Msg\_Ack\_Tx\ BitSync}$	Average current / Acknowledged Tx message in bit sync mode			55		µA
$I_{Msg\_Ack\_Tx\ 50000}$	Average current / Acknowledged Tx message in async mode at 50000 baud	4)		47		µA
$I_{Msg\ Ack\ Tx\ 38400}$	Average current / Acknowledged Tx message in async mode at 38400 baud	4)		50		µA
$I_{Msg\_Ack\_Tx\ 19200}$	Average current / Acknowledged Tx message in async mode at 19200 baud	4)		70		µA
$I_{Msg\_Ack\_Tx\_4800}$	Average current / Acknowledged Tx message in async mode at 4800 baud	4)		146		µA
I_{Peak}	Peak Current consumption			22		mA
I_{Maxt}	Peak current pulse width	3)		600	1000	µs
I_{PeakTx}	Peak Current – Tx only @ 0dBm			16		mA
I_{MaxTxt}	Tx only peak current pulse width				400	µs
I_{Ave}	Broadcast Tx-only @ 0.5Hz in byte sync mode	5)		30		µA

Symbol	Parameter (condition)	Notes	Min	Typ.	Max	Units
I_{Ave}	Broadcast Tx-only @ 2 Hz in byte sync mode	5)		52		µA
I_{Ave}	Broadcast Rx @ 0.5Hz in byte sync mode	5)		34		µA
I_{Ave}	Acknowledged Rx @ 0.5 Hz in byte sync mode	5)		38		µA
I_{Ave}	Acknowledged Tx @ 0.5 Hz in byte sync mode	5)		43		µA
I_{Ave}	Burst continuous @ 20Kbps in byte sync mode	5)		4.9		mA
I_{Ave}	Burst continuous @ 7.5Kbps in bit sync mode	5)		5.7		mA
I_{Ave}	Burst continuous @ 20Kbps in async mode at 50000 baud	5)		5.4		mA
I_{Ave}	Burst continuous @ 13.8Kbps in async mode at 38400 baud	5)		5.5		mA
I_{Ave}	Burst continuous @ 8.4Kbps in async mode at 19200 baud	5)		5.85		mA
	Transmitter operation					
P_{RF_Max}	Maximum output power	6)		1		dBm
P_{RF}	Typical output power	7)		0		dBm
P_{BW}	20dB bandwidth for modulated carrier				1000	kHz
P_{RF2}	2^{nd} adjacent channel transmit power 2MHz				-20	dBm
P_{RF3}	3^{rd} adjacent channel transmit power 3MHz				-40	dBm
I_{VCC}	Supply peak current @ 0dBm output power			16		mA
I_{VCC}	Supply peak current @ -20dBm output power			13		mA
	Receiver operation					
I_{VCC}	Supply peak current receive mode			22		mA
RX_{SENS}	Sensitivity at 0.1%BER (@1000kbps)			-80		dBm
C/I_{CO}	C/I co-channel			4		dB
C/I_{1ST}	1^{st} adjacent channel selectivity C/I 1MHz			0		dB
C/I_{2ND}	2^{nd} adjacent channel selectivity C/I 2MHz			-20		dB
C/I_{3RD}	3^{rd} adjacent channel selectivity C/I 3MHz			-30		dB

1) Usable band is determined by local regulations.
2) The internal clock source is used when the EXT32K is not available.
3) Maximum occurs during search operation when a receive channel is opened.
4) Asynchronous serial messages contained two 0 pad bytes, thereby adding to the average current. Values will be lower without the use of 0 pad bytes.
5) Values calculated assuming that EXT32K is used.
6) Maximum output power with 0dBm output power setting.
7) Variation from 2402MHz to 2479MHz.

Example Current Calculations:

1. Transmit Only channel with Broadcast data at 4Hz with a bit synchronous serial interface and EXT32K.

$$I_{ave} = (I_{Msg\_Tx\_BitSync} * Message\_Rate) + I_{Base\_EXT32K}$$

$$= (26\ \mu A/message * 4messages) + 35\ \mu A$$

$$= 139\ \mu A$$

2. Receive channel with Acknowledged data at 2Hz with an asynchronous serial interface at 50000 baud and no EXT32K.

$$I_{ave} = (I_{Msg\_Ack\_Rx\_50000} * Message\_Rate) + I_{Base}$$

$$= (38\ \mu A/message * 2messages) + 75\ \mu A$$

$$= 151\ \mu A$$

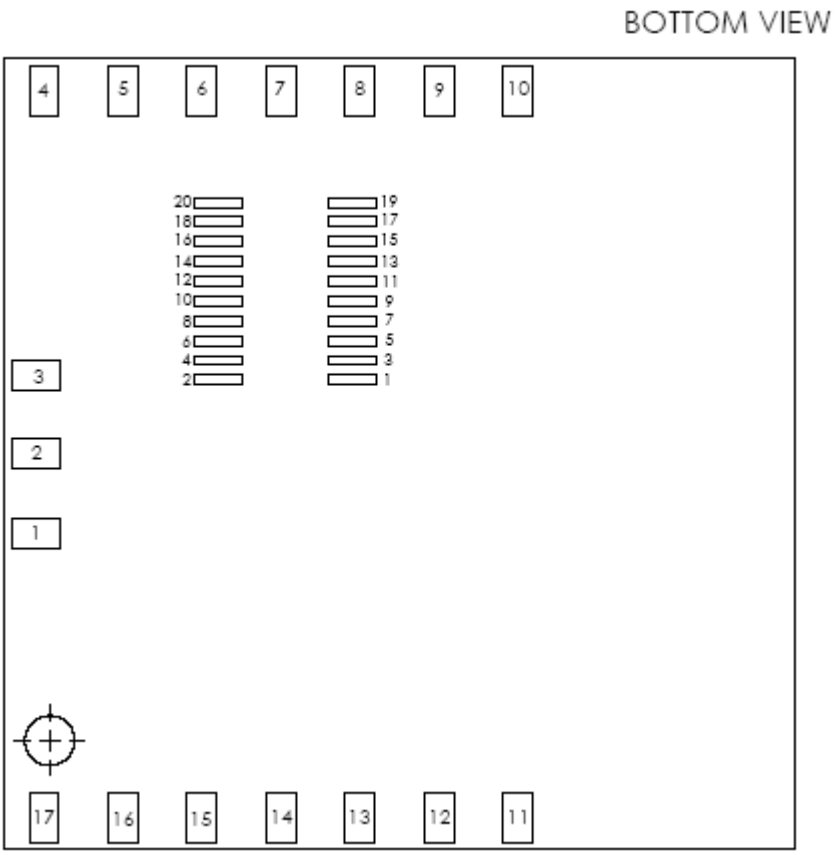
3.1 Reflow Guideline

Follow the guideline below if ANT11TxxM4IB modules go through reflow oven.

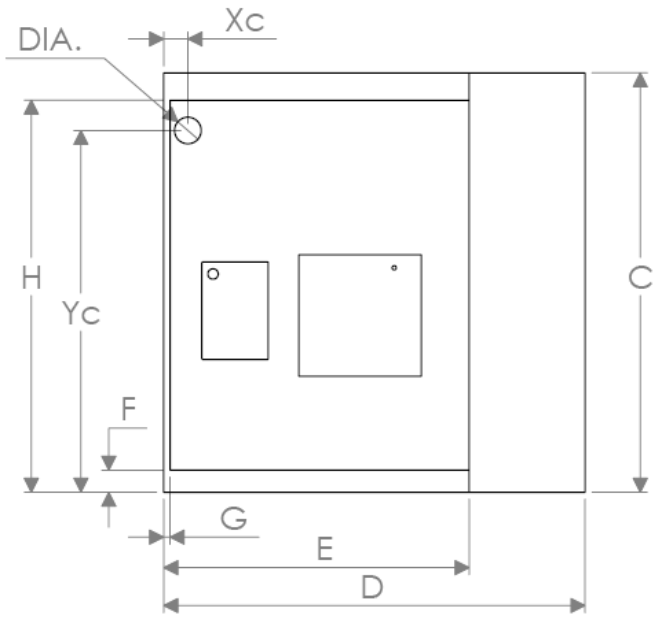
- Peak solder joint/pad temperatures exceeding 240ºC are not recommended.
- If possible, pre-heat the assembly within the oven profile for ~30 seconds at ~150 ºC.
- Follow the solder paste manufacturer's recommendations, especially regarding temperature ramp rate and the time above liquidus.

4 Connection Diagram

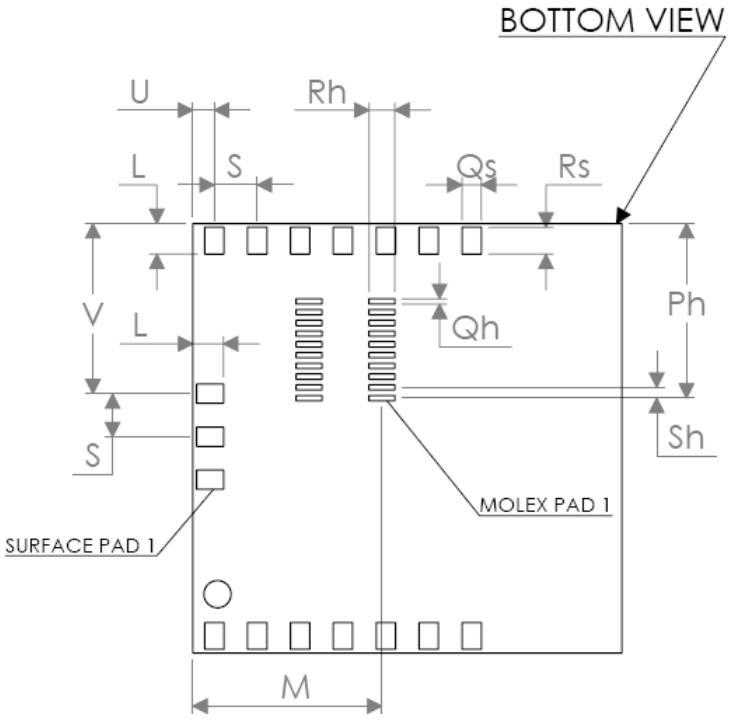
17 pin-out assignment style for ANTAP1M4IB and 20-pin header connection style for ANTAP1M5IB

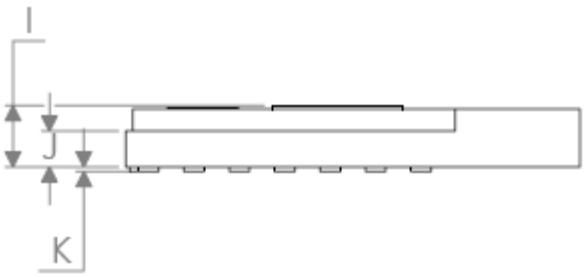


5 Module Mechanical Interconnect- ANTAP1M4IB

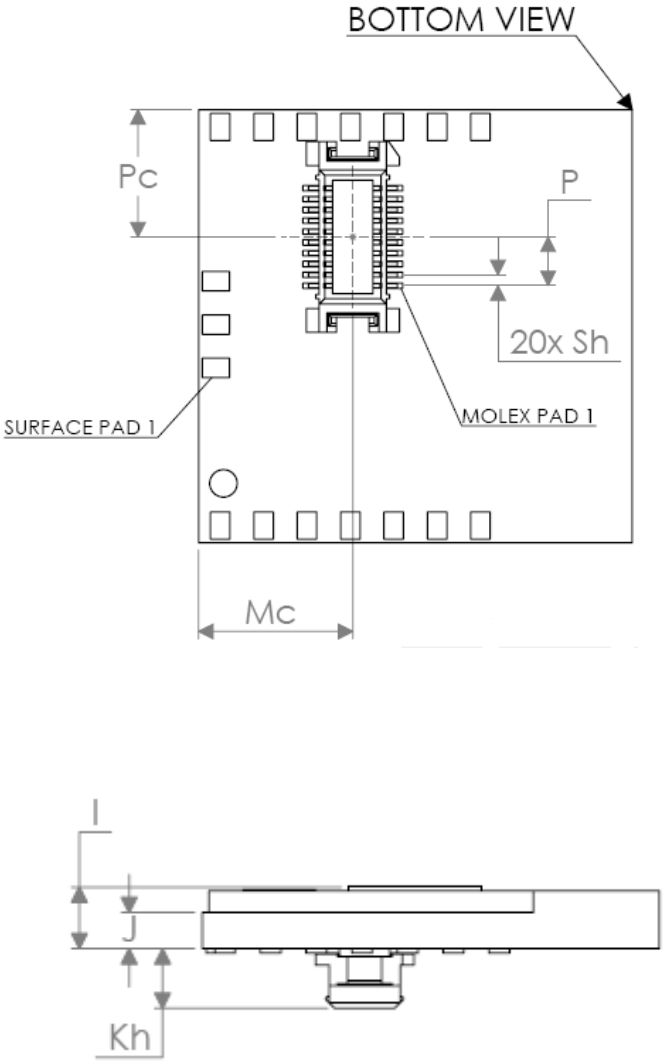


MODULE DIMENSIONS	
DIM.	VALUE (mm)
C	20.000±0.2
D	20.000±0.2
E	14.500
F	1.050
G	0.300
Xc	1.148±0.1
H	18.700
Yc	17.254±0.1
I	2.908 MAX.
J	1.588±0.16
K	0.1 MAX.
U	1.000
M	8.814
Ph	8.128
S	2.000
Sh	0.500
V	8.000
Qs	0.900
Rs	1.250
Qh	0.250
Rh	1.200
L	1.425
DIA.	Ø1.270±0.05



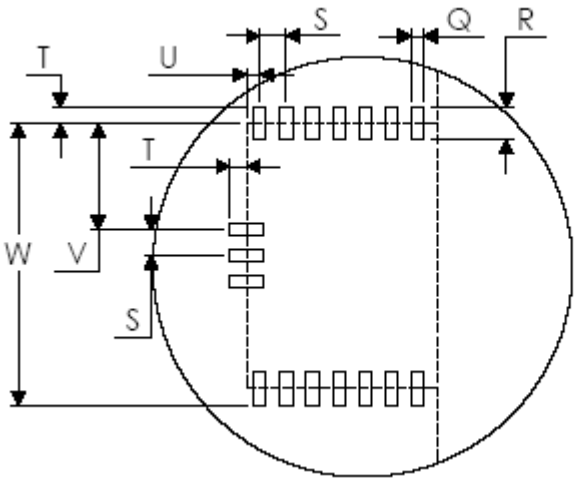


6 Module Mechanical Interconnect – ANTAP1M5IB



MODULE DIMENSIONS	
DIM.	VALUE (mm)
C	20.000±0.2
D	20.000±0.2
E	14.500
F	1.050
G	0.300
Xc	1.148±0.1
H	18.700
Yc	17.254±0.1
I	2.908 MAX.
J	1.588±0.16
Kh	2.625±0.2
Sh	0.500
Mc	7.114
P	2.250
Pc	5.878
DIA.	∅1.270±0.05

PN for the header on the module: Molex 53748-0208
PN for the mating connector: Molex 52991-0208



DETAIL C
SCALE 2 : 1

MODULE DIMENSIONS	
DIM.	VALUE (mm)
Q	1.100
R	2.700
S	5.500
T	1.100
U	40.000
V	40.000
W	21.300
RFx	5.500
RFg	40.000